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ULTRASONIC INSPECTION RESULTS FOR DOUBLE-SHELL TANK 241-AP-106 - FY 2005

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U.S. Department of Energy Contract DE-AC27-99RL14047

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Abstract: This report documents the ultrasonic examination of 241-AP-106. There was no reportable wall thinning detected in any of the plate areas examined. Small degrees of average wall thinning were observed in two courses, the 0.5625 inch thick Course and the 0.875 inch thick Course. The greatest single wall thinning is 9.0% in course 1. There were no crack like indications nor reportable pitting indications detected in any of the weld heat affected zones or wall courses.

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Ultrasonic Inspection Results for Double-Shell Tank 241-AP-106 – FY 2005

July 2005

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TERMS

ASME	American Society of Mechanical Engineers
CH2M HILL	CH2M HILL Hanford Group, Inc.
COGEMA Engineering	COGEMA Engineering Corporation
DST	double-shell tank
DSTIP	Double-Shell Tank Integrity Project
FY	fiscal year
HAZ	heat-affected zone
JCS	Job Control System
NDE	Nondestructive Examination
PDT	Performance Demonstration Test
PNNL	Pacific Northwest National Laboratory
RL	U.S. Department of Energy, Richland Operations Office
RMS	Root Mean Square
T-SAFT	Tandem Synthetic Aperture Focusing Technique
TWINS	Tank Waste Information Network System
TWRS	Tank Waste Remediation System
UT	Ultrasonic Testing
WDOE	Washington State Department of Ecology

EXECUTIVE SUMMARY

Background

Through FY 1999, six double-shell tanks were ultrasonically examined to meet the integrity requirements of the *Washington Administrative Code*, Chapter 173-303, "Dangerous Waste Regulations". Subsequent to the examinations, integrity assessment reports were issued for each double-shell tank farm and submitted to the Washington State Department of Ecology in FY 1999. In June 2000, the Washington State Department of Ecology issued Administrative Orders 00NWPKW-1250 and 00NWPKW-1251 providing prescriptive examination requirements for all double-shell tanks by FY 2005. In 2003, the Administrative Orders were incorporated into the Hanford Federal Facility Agreement and Consent Order, Milestones Series M-48. Milestone M-48-13 requires examination by September 30, 2005, of four DSTs not previously examined. This report documents the required ultrasonic examination of double-shell tank 241-AP-106, completed in the first quarter of FY 2005.

Methodology

The primary tank wall examinations consisted of a vertical 30-inch strip consisting of two 15-inch ultrasonic examination scans. The primary wall vertical examinations were looking for wall thinning, cracking, and pitting in the tank wall. The weld heat affected zones examined included 25 linear feet of vertical welds and 21 linear feet of horizontal welds. These examinations were performed using the P-scan nondestructive examination technique.

The ultrasonic examinations were carried out in accordance with ASME Boiler and Pressure Vessel Code, Section V, "Nondestructive Examinations". The personnel and non-destructive examination equipment were qualified to perform the examinations on the double-shell tanks by performance demonstration tests administered by Pacific Northwest National Laboratories.

The required accuracy for the ultrasonic examinations is to be within 0.020 inches for wall thinning, 0.050 inches for pitting, and 0.10 inches for cracking. The performance demonstration tests revealed that the examiners meet this requirement.

Results

There was no reportable wall thinning detected in any of the plate areas examined. The primary wall vertical scans yielded overall average wall thickness values that deviated from the nominal values by -0.001 to +0.023 inches. Small degrees of average wall thinning were observed in two plates, the 0.5625 inch thick Plate #3 (-0.006 inches) and the 0.875 inch thick Plate #5 (-0.012 inches). Of the 12 inch long vertical wall plate scans yielding minimums falling below the nominal values, the greatest deviation was 9.0% below the nominal (Plate #1, Scan 1), where reportable wall thinning is defined as greater than 10% below the nominal.

There were no reportable pitting indications nor any crack-like indications detected in any of the vertical wall plates.

There were no areas of reportable wall thinning, no crack-like indications nor reportable pitting indications detected in any of the weld heat-affected zones. This included the primary tank vertical weld scans and the knuckle-to-shell horizontal weld scan.

Conclusions

Based on the results of this examination (no reportable indications), the material condition of the tank is satisfactory for continued operation.

The tanks inspected to date are summarized in the following table.

Double-Shell Tanks Inspected Through November 2004

Double-Shell Tank	**Inspection Year (FY)**								
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
AN-101						x			
AN-102					x				
AN-105			x			(1)			
AN-106			x						
AN-107		x							
AP-101							X (3)		
AP-103							X (4)		
AP-104								x	
AP-105							x		
AP-106									x
AP-107				x					
AP-108				x		(2)			
AW-101					x				
AW-102						x	(5)		
AW-103	x								
AW-104						x			
AW-105					x				
AW-106						x			
AY-101					x	x	(1)		
AY-102			x						
AZ-101			x						
AZ-102							X (3)		
SY-101								x	
SY-102								x	
SY-103								x	

[1] Limited scope reexamination.

[2] Linear indication evaluated.

[3] Includes primary knuckle Synthetic Aperture Focusing Technique (T-SAFT) examination.

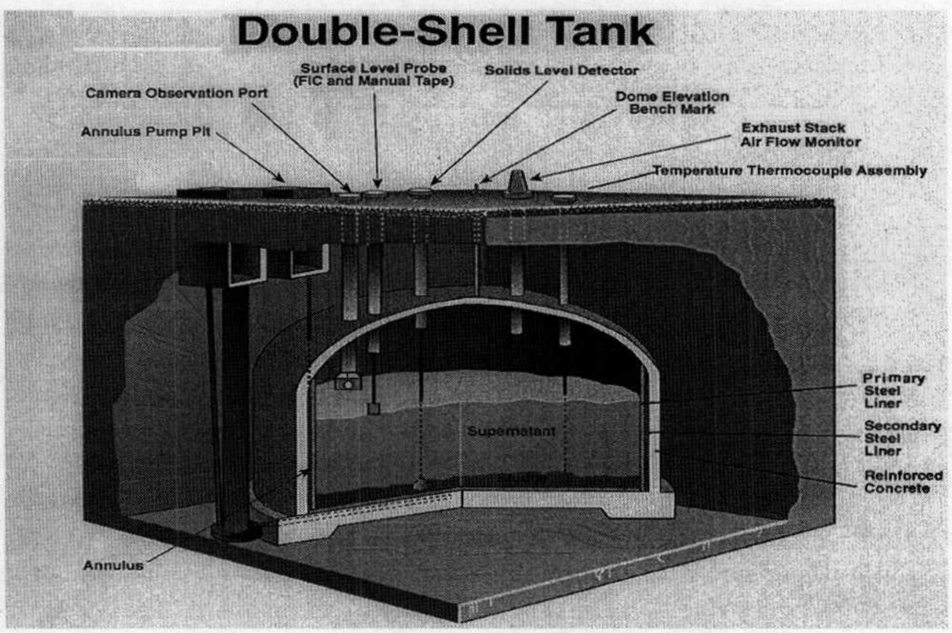
[4] Linear indication detected; A follow-up inspection determined that it is a small area of incomplete fusion.

[5] Primary knuckle T-SAFT examination only.

1.0 INTRODUCTION

In May 1996 the Tank Waste Remediation System (TWRS) Decision Board recommended, and U.S. Department of Energy, Richland Operations Office (RL) agreed, that the condition of the double-shell tanks (DST) should be determined by ultrasonic testing (UT) inspection of a limited area in six of the 28 DSTs (Figure 1-1). The Washington State Department of Ecology (WDOE) agreed with the strategy of limited ultrasonic inspection of DSTs. Data collected during the UT inspections will be used to assess the condition of the tank, judge the effects of past corrosion control practices, and satisfy a regulatory requirement to periodically assess the integrity of waste tanks.

Figure 1-1. Typical Double-Shell Tank Configuration



In November 1996, DST 241-AW-103 was the first tank inspected to determine if Hanford DST walls could be inspected without removing the existing surface rust and scale. Equipment similar to that used to perform routine inspections of oil tanks and large pipelines was used. UT sensors were mounted on a remote-controlled crawler that used magnetic wheels to affix itself and move about on the tank walls. The crawler was deployed into the tank annulus and vertically traversed the primary and secondary containment walls to collect data on the wall thickness and the size of any pits or cracks. The successful completion of this inspection met the requirements of RL Milestone T21-97-455 and represented the first UT inspection of a Hanford DST (*Final Report - Ultrasonic Examination of Tank 241-AW-103 Walls*, Leshikar 1997).

In fiscal year (FY) 1998, FY 1999, and FY 2000, similar inspections were performed per Engineering Task Plans HNF-2820 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks*, Pfluger 1999) and RPP-5583 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2000*, Jensen 2000) on 241-AN-107, 241-AN-106, 241-AN-105, 241-AY-102, 241-AZ-101, 241-AP-107, and 241-AP-108. An attempt was made to examine 241-AY-101 in FY 1999, but corrosion product on the tank wall prevented reliable examination.

In June 2000, WDOE issued an Administrative Order requiring UT examinations of the remaining 20 DSTs through FY 2005 (*Administrative Order No. 00NWPKW-1251, Failure to Comply with Major Milestone M-32 of the Tri-Party Agreement*, Silver 2000). In 2003, the WDOE Administrative Order (Silver 2000) was incorporated into the Hanford Federal Facility Agreement and Consent Order Milestone Series M-48 (HFFACO 2003), requiring examination during each FY through FY 2005 of four DSTs not previously examined. Based on the results of the above listed eight DST inspections and per the Milestone Series M-48 (HFFACO 2003), engineering task plans were prepared for ultrasonic DST inspections scheduled for the subsequent fiscal years.

In FY 2001, UT inspections were performed on four DSTs: 241-AN-102, 241-AW-101, 241-AW-105, and 241-AY-101 (following cleaning of selected areas of the 241-AY-101 wall). These DSTs were examined per Engineering Task Plan RPP-6839 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2001*, Jensen 2000a).

In FY 2002, UT inspections were performed on four more DSTs: 241-AN-101, 241-AW-102, 241-AW-104, and 241-AW-106. Also in FY 2002, a more extensive examination of 241-AY-101 was performed, and an examination of 241-AP-108 was limited to characterization of the linear indication found in FY 2000. In addition, a limited scope reexamination of the upper walls of tank 241-AN-105 was performed in FY 2002. These DSTs were examined per RPP-7869 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2002*, Jensen 2002), and RPP-8867 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks 241-AP-108, 241-AY-101, and 241-AZ-102 - FY2002*, Jensen 2002a).

In FY 2003, UT inspections were performed on four more DSTs: 241-AP-101, 241-AP-103, 241-AP-105, and 241-AZ-102. Also, a primary knuckle inspection on 241-AW-102 using the Tandem Synthetic Aperture Focusing Technique (T-SAFT) not completed during FY 2002 was completed in early FY 2003. In addition, a supplementary, limited scope examination of the tank 241-AY-101 secondary tank wall was completed. These DSTs were examined per RPP-11832 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2003*, Jensen 2002b).

In FY 2004, UT inspections were performed on four more DSTs: 241-SY-101, 241-SY-102, 241-SY-103, and 241-AP-104. A limited scope examination of tank 241-AN-105 originally planned for FY 2004 was deferred until FY 2005. These DSTs were examined per RPP-17750 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2004*, Jensen 2003).

In FY 2005, UT inspections were planned on four more DSTs: 241-AN-103, 241-AN-104, 241-AP-102, and 241-AP-106. Limited scope examinations of tanks 241-AN-101, 241-AN-105, 241-AP-104 and 241-SY-101 were also planned for FY 2005. These DSTs were to be examined per RPP-22571 (*Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks - FY2005*, Jensen 2005).

DST 241-AP-106 was the first of the four tanks selected for standard inspection in FY 2005. Inspections of the tank 241-AP-106 walls and welds were completed in the first quarter of FY 2005, and is the subject of this report. The services of COGEMA Engineering Corporation (COGEMA Engineering) were retained to provide UT examinations, procedures and inspectors, and report the inspection results. Examination of 241-AP-106 was performed with UT equipment provided by CH2M HILL Hanford Group, Inc. (CH2M HILL).

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2.0 OBJECTIVE AND SCOPE

This report describes the inspection system, evaluates the inspection results, and documents findings with conclusions and recommendations. The inspections were conducted in accordance with the criteria and scope set forth in RPP-22571 (Jensen 2005) for the FY 2005 UT inspection of DST 241-AP-106.

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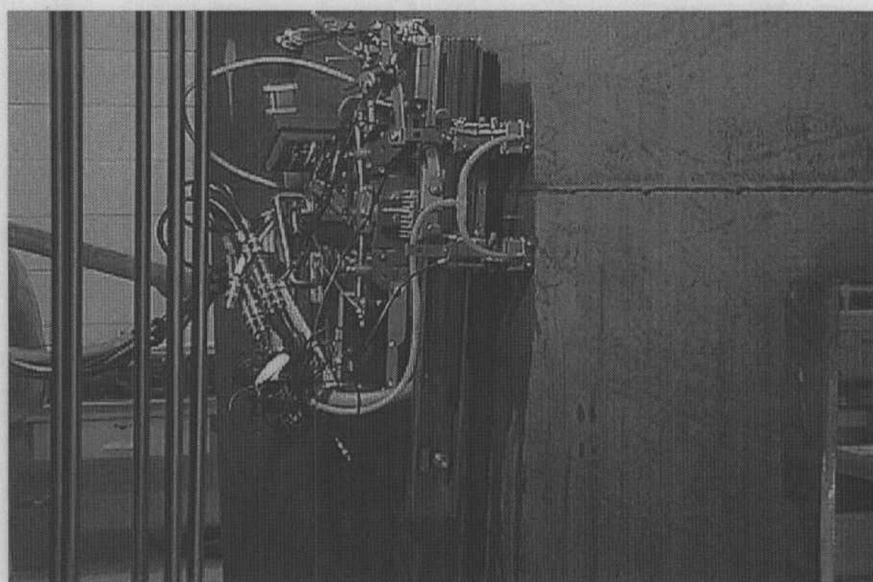
3.0 INSPECTION EQUIPMENT DESCRIPTION

Crawler / Scanning Bridge Systems – The crawler is a remotely controlled device that delivers the ultrasonic transducers to the tank walls. The crawler used during most P-scan imaging weighs approximately 35 pounds and has dimensions (including its traveling bridge) of approximately 21 inches wide by 18 inches long by 6 inches high. The traveling bridge on the crawler can be outfitted with various ultrasonic transducer configurations (Figure 3-1).

Figure 3-1. P-scan Crawler System on Tank Mock-up



The crawler system was deployed through a 24 inch annulus inspection riser using a customized deployment tool. The P-scan tank wall crawler attaches to the tank wall with two pairs of magnetic wheels. As the crawler moves slowly forward the transducers glide from side-to-side over the tank wall surface. Water couplant is continuously fed to all transducers at a rate needed to maintain an acceptable signal.

Deployment Tool – A deployment tool was specifically designed to insert and retrieve the scanning system into and out of the DST annular space. The scanner sits on a platform that is manually lowered to the appropriate elevation. The platform has cables attached that can be controlled to move the scanner platform into contact with the examination surface. The scanner is then driven onto the surface. The deployment tool is retracted until the scanner needs to be removed from the annular space.

P-scan – P-scan is the name of the computerized pulse-echo ultrasonic inspection system used by the inspection vendor. The P-scan system is manufactured by Force Institute in Denmark. It acquires data from zero and angle beam transducers mounted on the crawler, allows real-time analysis, and records the data in electronic memory for post inspection analysis. Force Institute has designated "P-scan mode" to represent the angle beam (flaw length) view and "T-scan mode" to represent the zero beam (thickness) view. T-scan mode is used for normal operation and, if crack-like indications are detected, then the P-scan mode is employed.

During normal T-scan and P-scan operations, the waveforms of the reflected sound wave signals for each transducer are displayed in the "A-scan monitoring mode". The displays are continuously monitored (but not saved), and are primarily used to verify that the transducers are functioning properly (e.g., there is proper probe contact, adequate water flowing, and correctly operating transducer cables). When an indication is detected, the area is rescanned using the "A-scan recording mode". The recorded A-scan waveforms are then reviewed off-line, serving as an additional tool in the evaluation of the indication.

Overview Camera – This camera was deployed to observe the area immediately around the inspection area and to aid crawler deployment in the annulus.

Side-view Camera – This camera and light system were installed in a riser adjacent to the inspection riser to provide an overall view of the inspection process.

Riser Enclosure – A modular structure that is placed over the inspection riser. This structure is used to combat adverse weather conditions and supplies an internal hoist for deployment of equipment.

Data Acquisition Control Center – A pull-type trailer was used to house the crawler controls, video monitors, and data collection and evaluation hardware. The trailer was located inside the AP Tank Farm boundary fence.

4.0 UT INSPECTION DESCRIPTION

The following is the description of the data collection methodology:

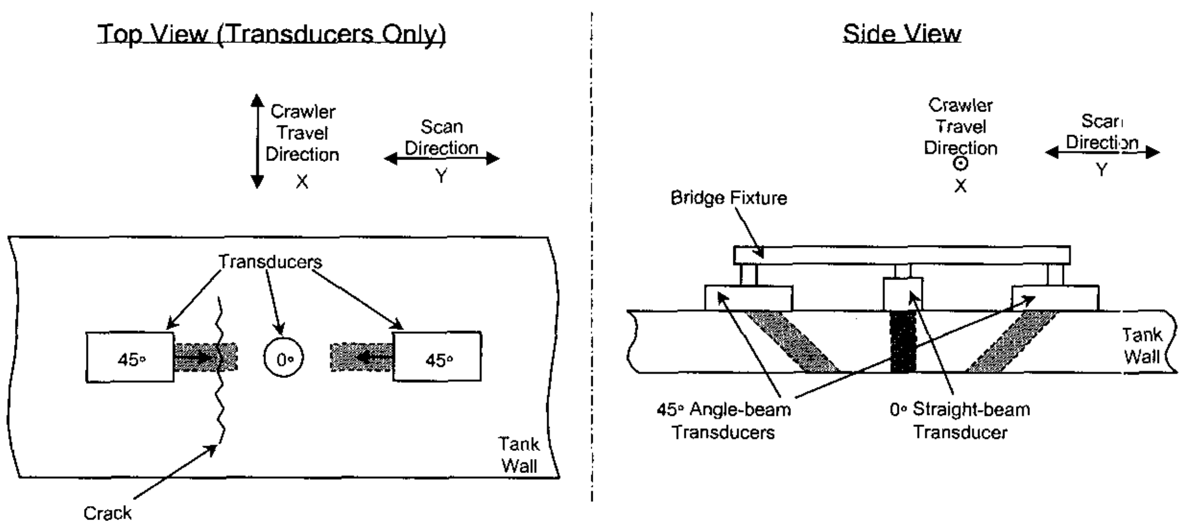
Tank inspection was performed under Job Control System (JCS) work package number 2E-04-1854. All work steps, guidelines, procedures, personnel responsibilities, and protocol for the inspection (Jensen 2005) were included in the subject work package. The COGEMA Engineering procedure that establish the methods, equipment and requirements for the P-scan imaging system UT measurements and flaw detection is *Automated Ultrasonic Examination For Corrosion And Cracking*, COGEMA-SVUT-INS-007.3 (Attachment 1).

A single remote crawler system was utilized for the various DST 241-AP-106 inspections:

P-scan Crawler for Tank Walls - A remotely controlled, steerable crawler was used to deliver the P-scan UT transducers to the tank wall (Figure 3-1). The crawler was deployed through the 24 inch diameter annulus inspection Riser Number 030 to perform the vertical wall scans and the vertical and horizontal weld scans.

The P-scan crawler inspects the primary tank wall using one dual-element 0° transducer to detect wall thinning and corrosion pitting, and two 45° shear-wave transducers to detect cracking transverse to the scanning direction. This examination setup is illustrated in the Figure 4-1 schematic.

Figure 4-1. Schematic of UT Setup for Vertical Wall Inspection

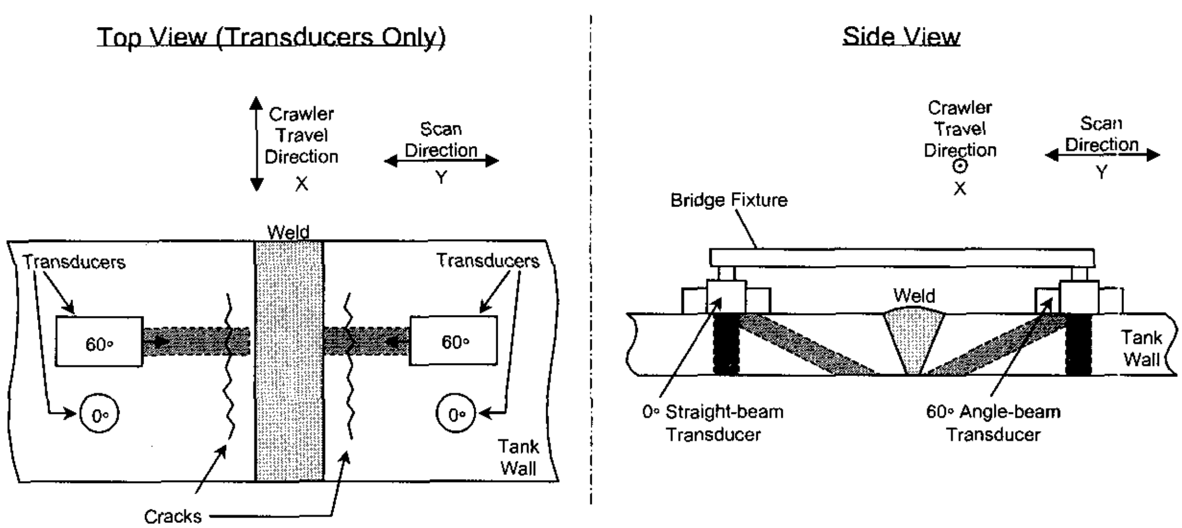


Vertical Wall Inspection Setup – Uses two 45° Transducers and one 0° Transducer (Inspect for Wall Thinning, Pitting and Axial Cracks)

Note that the examination of the welds and heat affected zones (HAZ) actually consist of angle beam examinations in the HAZ. The welds are not directly examined since the physical configuration does not permit transducer placement on the weld. This physical configuration is the weld crown. The DSTs were not designed or fabricated for in-service inspection, and therefore the weld crowns were not prepared for examination.

To detect cracks parallel to the weld, a 60° shear-wave transducer was directed toward the weld and a dual-element 0° transducer is also included to detect wall thinning and corrosion pitting (Figure 4-2). The examination of the HAZ using 60° angle beams will provide some coverage of the actual weld to the inside surface. For example, in a previous UT examination, a "lack of fusion" in a weld was identified (*Ultrasonic Inspection Results for Double-Shell Tank 241-AP-103*, Jensen 2003a).

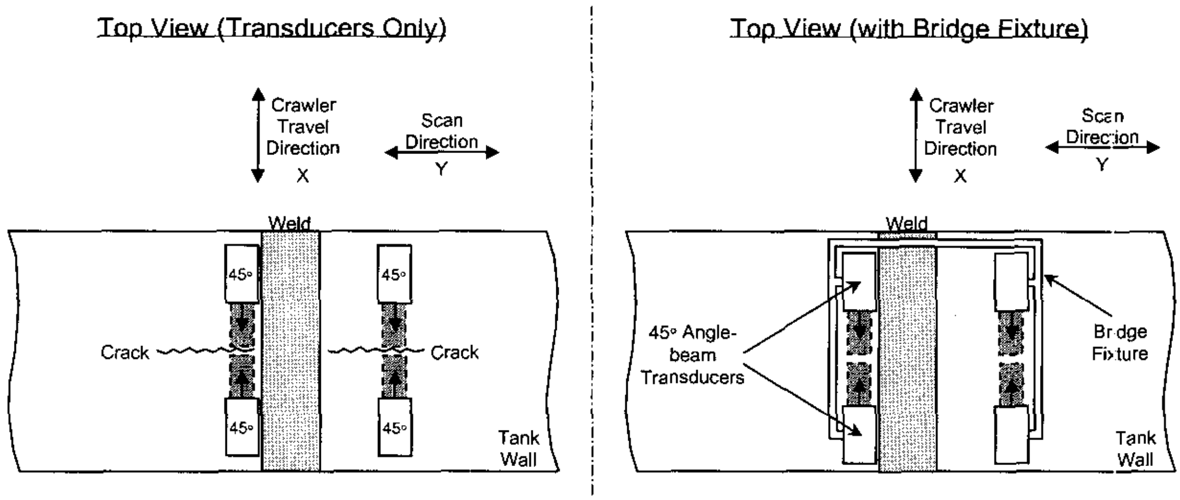
Figure 4-2. Schematic of UT Setup for First Pass of Weld Inspections



First Pass of Vertical and Horizontal Weld Inspection – Uses two 60° Transducers and two 0° Transducers (Inspect for Wall Thinning, Pitting and HAZ Cracks Parallel to the Weld)

To detect cracks oriented perpendicular to welds, two opposing 45° shear-wave transducers were directed parallel to the weld. Welds were examined from both sides of the weld crown (Figure 4-3).

Figure 4-3. Schematic of UT Setup for Second Pass of Weld Inspections



Second Pass of Vertical and Horizontal Weld Inspection – Uses four 45° Transducers (Inspect for Heat-Affected Zone Cracks Perpendicular to the Weld)

Data and images from the P-scan crawler were returned to a nearby control center located inside the tank farm fence. The control center contained the crawler controls, video monitors, and data collection and evaluation software and hardware. The UT inspector continuously monitored the signals for reportable indications.

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5.0 INDICATION REPORTING CRITERIA

COGEMA Engineering was required to report to the customer the following anomalies:

- Wall thinning that exceeded 10 percent of the nominal wall thickness
- Pit depths that exceeded 25 percent of the nominal wall thickness
- Cracks that exceeded 0.1 inch in depth

The reporting criteria is established to identify indications that should be tracked. This tracking is to be used to determine if there is any active mechanism causing additional thinning, pit growth, or crack growth, based on subsequent examinations on the eight to ten year examination interval. The values are nominally 50% of the "acceptance criteria" established in *Acceptance Criteria for Non-Destructive Examination of Double-Shell Tanks* (Jensen 1995) and recommended in *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks* (Bandyopadhyay et al. 1997).

For indications exceeding the "acceptance criteria", actions are initiated to evaluate the operability of the DST (Jensen 2005) through the occurrence reporting process. Indications exceeding the "reporting criteria" are reported to the CH2M HILL Project Engineer to be documented in the inspection report (Jensen 2005).

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6.0 PERFORMANCE DEMONSTRATION TESTS

Prior to field use, COGEMA Engineering personnel satisfactorily completed a performance demonstration test (PDT). The test was conducted to qualify personnel, test procedures, and ensure the equipment's ability to detect and size wall thinning, pits, and cracks in a series of test plates with artificial defects. The performance demonstration test was performed on a tank mock-up in the 306E Facility located in the Hanford Site 300 Area. This mock-up also demonstrated the successful deployment and retrieval of the equipment. The PNNL report, "*Report on Performance Demonstration Test – PDT, May 2000,*" (Attachment 3 of *Ultrasonic Inspection Results of Double-Shell Tank 241-AP-108*, Jensen 2000b) provides the details of the complete evaluation of the P-scan system PDT.

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7.0 TANK 241-AP-106 HISTORY

The 241-AP Tank Farm consists of eight DSTs located in the 200 East Area of the Hanford Site. These underground tanks were built from 1983 through 1986, and are 75 feet in diameter with an operating capacity of 1.16 million gallons.

Tank 241-AP-106 entered service in August 1986 with a small volume of flush water. In 1988 the tank received a substantial volume of dilute non-complexed waste from the 242-A Evaporator and 3000 gallons of waste was sent to the Hanford Grout Treatment Facility for disposal. In early 1989 waste from tank 241-AP-106 was transferred to the 242-A Evaporator and a reduced volume of waste was received from the same. Tank 241-AP-106 received a small amount of dilute non-complexed waste from tank 241-AW-106 before transferring a majority of its inventory to tank 241-AP-105. In late 1989 the tank received its largest transfer to date from tank 241-AY-102 which was mostly B-Plant vessel cleanout and B-Plant strontium processing wastes. A second transfer from tank 241-AY-102 in 1989 filled tank 241-AP-106 close to capacity where it remained until March 1995.

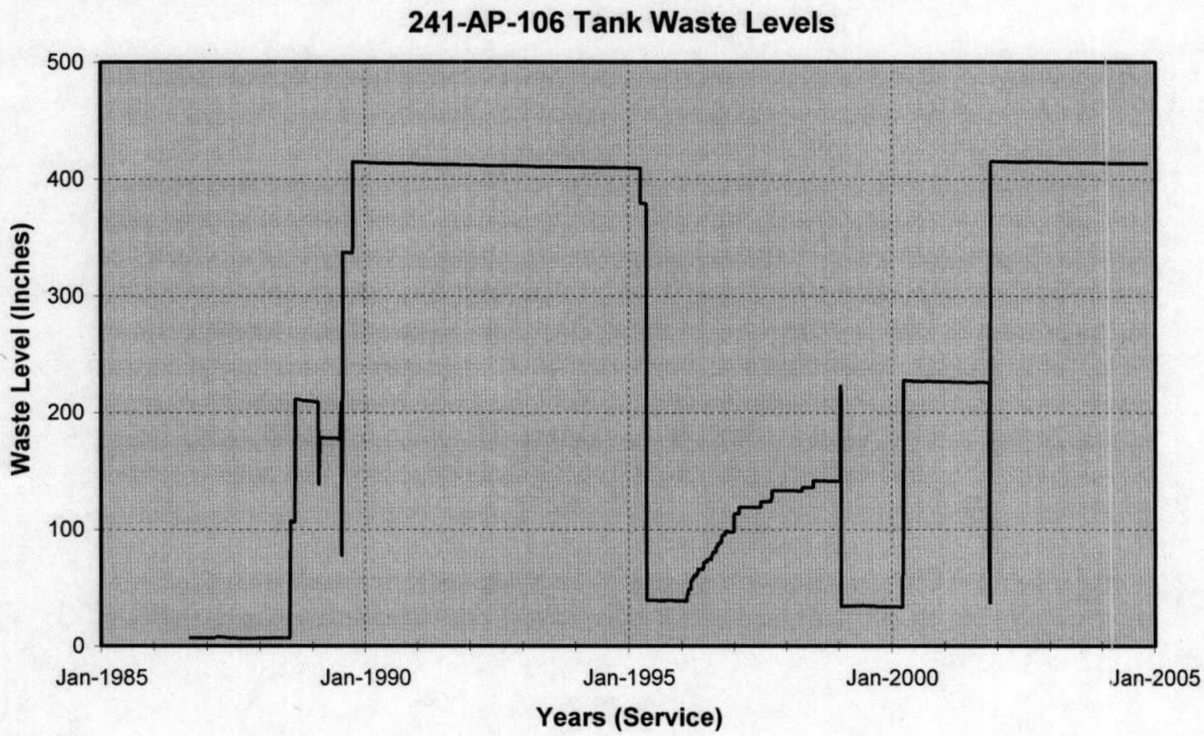
Tank 241-AP-106 was almost emptied in March 1995 with a small transfer to tank 241-AW-102 and a larger transfer to tank 241-AP-108. It then began collecting small volumes of water and dilute non-complexed waste from various sources including B-Plant cells, the 300 and 400 areas, the 222-S Laboratory, T-Plant, and the Plutonium Finishing Plant Laboratories. The tank was again almost emptied in 1999 with another transfer to tank 241-AP-108. In 2000 more miscellaneous flush water was added with a substantial dilute non-complexed waste addition from tank 241-SY-102, leaving the tank about half-filled. (*Tank Characterization Report for Double-Shell Tank 241-AP-106*, Adams 2001).

Tank 241-AP-106 currently contains approximately 1,137,000 gallons of supernatant waste equivalent to a level of approximately 413 inches. The tank is categorized as sound. (*Waste Tank Summary Report for Month Ending September 30, 2004*, Hanlon 2004).

The waste level history since September 1986 is shown in Figure 7-1, based on data obtained from the Tank Waste Information Network System (TWINS)[1].

[1] TWINS, http://twins.pnl.gov/twins.htm, queried 12/01/2004 [Data Source: Measurements, SACS, Surface Level, Tank Name AP-106, All Measurement Date values]

Figure 7-1. Waste Level History of Double-Shell Tank 241-AP-106



Since 1989, the minimum recorded waste level was approximately 33 inches (March 2000), and the maximum recorded waste level was approximately 415 inches (October 1989 and November-December 2001). During the 5-1/2 year period between October 1989 and March 1995, the waste level remained relatively constant, averaging 412 inches. Since November 2001, the waste level has also been relatively constant, averaging 414 inches.

Since July 1989, recorded temperatures of the tank have ranged from a maximum of 82°F (April 2000) to a minimum of 54°F (March 1996), and have averaged 66°F. This is based on data obtained from the TWINS[2].

---

[2] TWINS, http://twins.pnl.gov/twins.htm, queried 12/01/2004 [Data Source: Measurements, SACS, Tank Temperature Readings, Tank Name AP-106, All Measurement Date values].

8.0 GENERAL REQUIREMENTS AND INSPECTION SCOPE

FY 2005 Contract Number 21186, Release 30, specifies that the contractor provide (among others) the following deliverables to the Double-Shell Tank Integrity Project (DSTIP) organization:

- The contractor shall provide AP-106 NDE Support and Data Analysis
- The contractor shall prepare recommended engineering reports and studies as directed by the DSTIP project leads

The areas on the primary tank that were identified for UT inspection in the engineering task plan (Jensen 2005) and work package number 2E-04-1854 are described below.

Primary Tank Wall and Welds:

- A vertical strip (approximately 30 inches wide by 35 feet long) of the primary wall between the upper haunch transition and the lower knuckle for pits, cracks, and wall thinning. The vertical strip may be comprised of one or more strips whose total width is 30 inches.
- Twenty feet of the circumferential weld joining the cylinder to the lower knuckle, one vertical weld joining the lowest shell plate plates (about 10 feet of weld), and one vertical weld joining the next to the lowest shell plate plates (about 10 feet of weld). A minimum of twenty (20) feet of vertical weld shall be examined.

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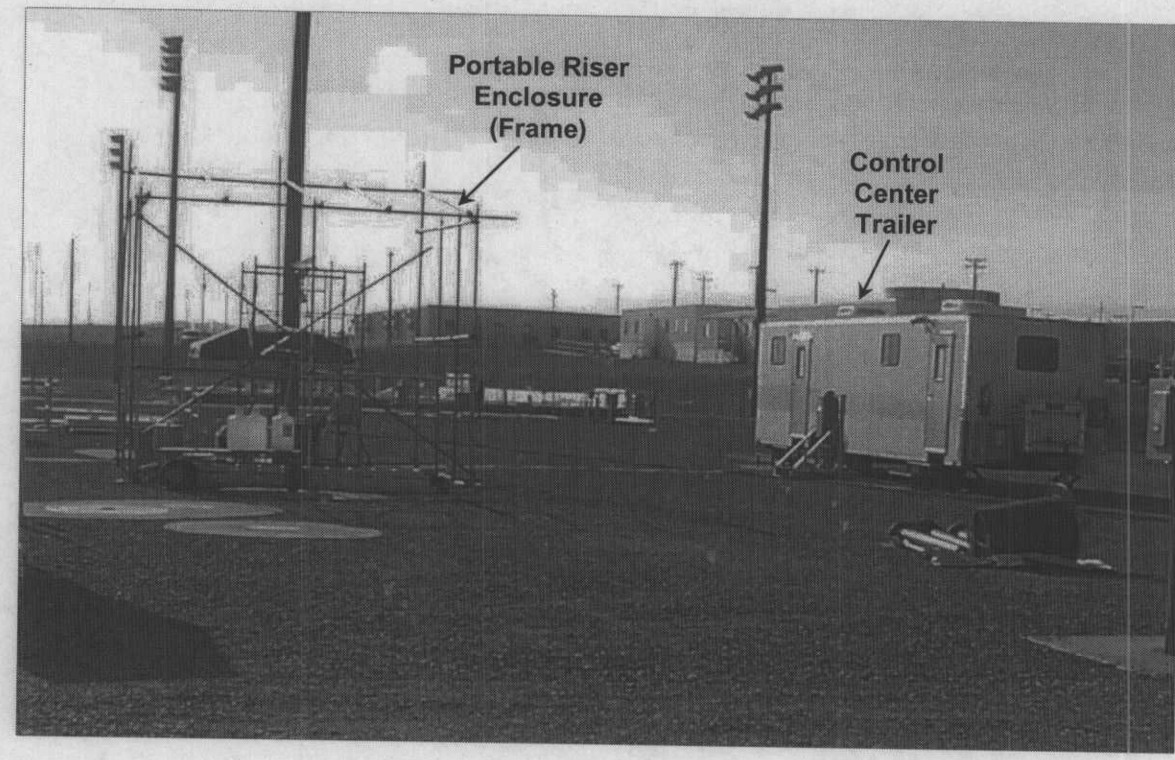
9.0 EQUIPMENT SETUP AT AP TANK FARM

Prior to performing the actual inspection, the shield plug was removed from the 24 inch Riser 030, and a temporary cover and riser extension were secured to the riser. A portable enclosure was installed over the riser to provide the means for deploying the UT equipment and protecting the operators from the weather. An electric chain hoist, mounted to the roof frame, was used for maneuvering the equipment into position. The control center trailer was set up inside the AP Tank Farm's boundary fence, and the control cables were run along the ground to the equipment located at the riser. A typical tank farm setup for the AP-Farm is shown in Figure 9-1.

Figure 9-1. Field Set-Up at Riser for Double-Shell Tank on AP-Farm



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10.0 INSPECTION RESULTS

Tank 241-AP-106 was fabricated from carbon steel plate. The primary tank's exterior surface varies from mill scale to coatings of various degrees of rust caused by in-service corrosion of carbon steel. A description of the plates is as follows with the location of the plates as shown in Figure 10-1 (*Tank Cross Section 241-AP Tanks*, Braun-Hanford 1986).

Primary Knuckle (top) – Connects dome of tank to side-wall

Primary wall – Consists of (from top to bottom)
Plate #1 – approximately 7 feet 8 inch tall, 1/2 inch nominal thickness
Plate #2 – approximately 7 feet 8 inch tall, 1/2 inch nominal thickness
Plate #3 – approximately 7 feet 8 inch tall, 9/16 inch nominal thickness
Plate #4 – approximately 9 feet tall, 3/4 inch nominal thickness
Plate #5 – approximately 2 feet tall, 7/8 inch nominal thickness

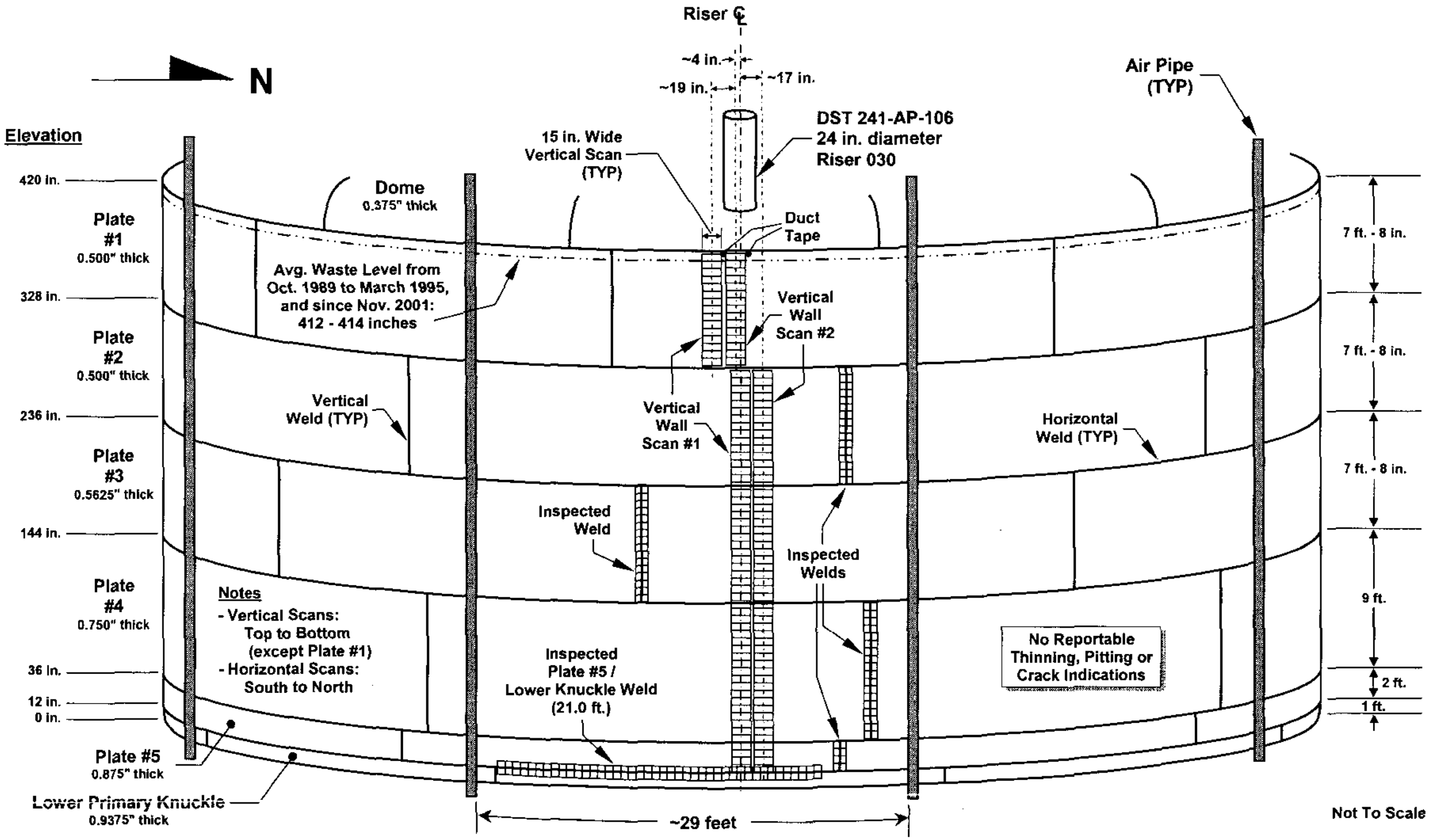
Primary Knuckle (bottom) – Approximately 15/16 inch nominal thickness. Connects sidewall of tank to primary tank bottom.

Primary Tank Bottom – Connected to primary knuckle. The outer three feet is approximately 7/8 inch nominal thickness, transitioning to 1/2 inch nominal thickness.

The P-scan crawler was deployed through the 24 inch diameter annulus inspection Riser 030 at the east side of tank 241-AP-106 for examinations of the primary tank wall, and the vertical and horizontal welds. All tank welds examined were in the "as-welded" condition. The various scan paths for the crawlers are shown in Figure 10-1, along with other pertinent tank information. Note that for Plate #1 only, the vertical wall scans were performed from the plate bottom to the plate top. This was due to the interference of the recently modified crawler cable bracket with the secondary dome if the scans were performed from the customary top to bottom. Both Plate #1 scans were also started at radial locations north of the centerline of the riser rather than at their usual locations (refer to scans for Plates #2 through #5). This was due to the presence of duct tape on the Plate #1 plate that prevented scans at the usual locations.

The UT P-scan data were examined by COGEMA Engineering's Level III certified inspector and by Limited Level II certified inspectors. The Limited Level II inspectors were "P-scan Limited", indicating that they are qualified to collect and examine the P-scan data, but are not qualified to interpret the data.

Figure 10-1. Schematic of UT Scan Paths on East Side of Tank 241-AP-106 Wall (via Riser 030)



The following pages contain tables that present summary and detailed wall thickness data, which were derived from the COGEMA "Automated Ultrasonic Thickness Data Report Sheets". The inspection data sheets, the transducer calibration sheets, the original tank wall and weld scan map, and an interpretation of the data by an independent Level III certified NDE Inspector are included in Attachment 2 for the P-scan data.

Tables 10-1 through 10-4 show the summarized minimum wall thickness values obtained using the P-scan system on the primary tank vertical walls, vertical plate welds, and horizontal knuckle weld. Although the data are reported to three significant figures, the accuracy of the wall thickness data, based on the results of the performance demonstration test, is 0.012 inch root-mean-square (RMS).

Table 10-1. Summary of Primary Tank Wall Scan 1 (via Riser 030)

Plate Description	Elevation of Wall Scan (inches)	Wall Scan Distance (inches) (1)	Design Nominal (inches)	Measured Minimum (inches)	Scan Minimum % of Nominal
Plate #1	419.3 to 329	90.3	0.500	0.455	91.0%
Plate #2	327 to 239.6	87.4	0.500	0.498	99.5%
Plate #3	235 to 146.6	88.4	0.5625	0.553	98.3%
Plate #4	143 to 39.6	103.4	0.750	0.752	100 3%
Plate #5	35 to 15.1	19.9	0.875	0.854	97.6%

(1) All scan widths were 15 inches.

Table 10-2. Summary of Primary Tank Wall Scan 2 (via Riser 030)

Plate Description	Elevation of Wall Scan (inches)	Wall Scan Distance (inches) [1]	Design Nominal (inches)	Measured Minimum (inches)	Scan Minimum % of Nominal
Plate #1	419.3 to 329	90.3	0.500	0.505	101.0%
Plate #2	327 to 238.8	88.2	0.500	0.489	97.8%
Plate #3	235 to 146.4	88.6	0.5625	0.539	95.8%
Plate #4	143 to 38.9	104.1	0.750	0.747	99.6%
Plate #5	35 to 15.5	19.5	0.875	0.867	99.1%

(1) All scan widths were 15 inches.

Table 10-3. Summary of Primary Tank Weld Scans (via Riser 030)

Weld Description	Elevation of Weld Scan (inches)	Weld Scan Distance (inches) [1]	Design Nominal (inches)	Measured Minimum (inches)	Scan Minimum % of Nominal
Vertical Weld Plate #2	327 to 238	89.0	0.500	0.481	96.2%
Vertical Weld Plate #3	235 to 147.7	87.3	0.5625	0.532	94.6%
Vertical Weld Plate #4	143 to 42.1	100.9	0.750	0.723	96.4%
Vertical Weld Plate #5	35 to 14.7	20.3	0.875	0.848	96.9%

(1) Scan widths were 11.0 – 11.5 inches.

Table 10-4. Summary of Plate #5 / Knuckle Horizontal Weld Scans (via Riser 030)

Weld Description	Vertical Location of Weld Scan	Weld Scan Distance (inches) (1)	Design Nominal (inches)	Measured Minimum (inches)	Scan Minimum % of Nominal
Horizontal Weld Plate #5 to Knuckle, Plate #5 Side	From ~1 in. to ~4.85 in. above Plate #5 / Knuckle Weld	252.5	0.875	0.825	94.3%
Horizontal Weld Plate #5 to Knuckle, Knuckle Side	From ~1 in. to ~4.85 in. below Plate #5 / Knuckle Weld	252.5	0.9375	0.904	96.4%

(1) Scan widths were 9.7 inches

Tables 10-5 through 10-14 contain the detailed data for wall scans as presented in 12 inch long by 15 inch wide connecting scans. The detailed data for vertical and horizontal welds are presented in 12 inch long by 9.7 to 11.5 inch wide scans in Tables 10-15 through 10-20.

Table 10-5. Primary Tank Vertical Wall Scan 1 – Plate #1 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / Plate 1" (Page Att. 2-3)	329	0 – 12 (1)	0.500	0.520	0.511
	341	12 – 24	0.500	0.525	0.518
	353	24 – 36	0.500	0.525	0.519
	365	36 – 48	0.500	0.525	0.504
	377	48 – 60	0.500	0.525	0.505
	389	60 – 72	0.500	0.525	0.518
	401	72 – 84	0.500	0.520	0.499
	413	84 – 90.3	0.500	0.515	0.455

(1) Scan start was 1 inch above the centerline of the second horizontal weld, and 19 inches south of the centerline of Plate #1 Scan 2; Scanned from bottom to top of plate; Scan width was 15 inches.

Table 10-6. Primary Tank Vertical Wall Scan 1 - Plate #2 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / Plate 2" (Page Att. 2-5)	327	0 – 12 [(1)]	0.500	0.518	0.510
	315	12 – 24	0.500	0.520	0.518
	303	24 – 36	0.500	0.520	0.518
	291	36 – 48	0.500	0.520	0.518
	279	48 – 60	0.500	0.523	0.519
	267	60 – 72	0.500	0.522	0.498
	255	72 – 84	0.500	0.520	0.502
	243	84 – 87.4	0.500	0.518	0.499

[(1)] Scan start was 1 inch below the centerline of the second horizontal weld, and centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-7. Primary Tank Vertical Wall Scan 1 - Plate #3 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / Plate 3" (Page Att. 2-7)	235	0 – 12 [(1)]	0.5625	0.564	0.559
	223	12 – 24	0.5625	0.565	0.559
	211	24 – 36	0.5625	0.568	0.563
	199	36 – 48	0.5625	0.568	0.555
	187	48 – 60	0.5625	0.568	0.565
	175	60 – 72	0.5625	0.566	0.561
	163	72 – 84	0.5625	0.564	0.560
	151	84 – 88.4	0.5625	0.564	0.553

[(1)] Scan start was 1 inch below the centerline of the third horizontal weld, and centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-8. Primary Tank Vertical Wall Scan 1 – Plate #4 (via Riser 030)

Scan I.D. Number (Data Sheets)	**Elevation of Start of Wall Scan (inches)**	**Vertical Location of Wall Scan (inches)**	**Design Nominal (inches)**	**Measured Average (inches)**	**Measured Minimum (inches)**
Scan "Vert. Wall / Plate 4" (Page Att. 2-9)	143	0 – 12 (1)	0.750	0.769	0.763
	131	12 – 24	0.750	0.769	0.766
	119	24 – 36	0.750	0.769	0.766
	107	36 – 48	0.750	0.769	0.752
	95	48 – 60	0.750	0.769	0.764
	83	60 – 72	0.750	0.769	0.765
	71	72 – 84	0.750	0.772	0.764
	59	84 – 96	0.750	0.770	0.763
	47	96 – 103.4	0.750	0.764	0.753

(1) Scan start was 1 inch below the centerline of the fourth horizontal weld, and centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-9. Primary Tank Vertical Wall Scan 1 – Plate #5 (via Riser 030)

Scan I.D. Number (Data Sheets)	**Elevation of Start of Wall Scan (inches)**	**Vertical Location of Wall Scan (inches)**	**Design Nominal (inches)**	**Measured Average (inches)**	**Measured Minimum (inches)**
Scan "Vert. Wall / Plate 5" (Page Att. 2-11)	35	0 – 12 (1)	0.875	0.875	0.864
	23	12 – 19.9	0.875	0.873	0.854

(1) Scan start was 1 inch below the centerline of the fifth horizontal weld, and centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-10. Primary Tank Vertical Wall Scan 2 – Plate #1 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / 2nd / Plate 1" (Page Att. 2-13)	329	0 – 12 (1)	0.500	0.520	0.505
	341	12 – 24	0.500	0.525	0.510
	353	24 – 36	0.500	0.525	0.519
	365	36 – 48	0.500	0.525	0.513
	377	48 – 60	0.500	0.525	0.520
	389	60 – 72	0.500	0.525	0.519
	401	72 – 84	0.500	0.520	0.516
	413	84 – 90.3	0.500	0.520	0.510

(1) Scan start was 1 inch above the centerline of the second horizontal weld, and 4 inches south of the centerline of 24 inch Riser 030; Scanned from bottom to top of plate; Scan width was 15 inches.

Table 10-11. Primary Tank Vertical Wall Scan 2 – Plate #2 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / 2nd / Plate 2" (Page Att. 2-15)	327	0 – 12 (1)	0.500	0.513	0.489
	315	12 – 24	0.500	0.515	0.512
	303	24 – 36	0.500	0.517	0.502
	291	36 – 48	0.500	0.517	0.502
	279	48 – 60	0.500	0.518	0.499
	267	60 – 72	0.500	0.519	0.513
	255	72 – 84	0.500	0.517	0.494
	243	84 – 88.2	0.500	0.515	0.496

(1) Scan start was 1 inch below the centerline of the second horizontal weld, and 17 inches north of the centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-12. Primary Tank Vertical Wall Scan 2 - Plate #3 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / 2nd / Plate 3" (Page Att. 2-17)	235	0 – 12 (1)	0.5625	0.567	0.539
	223	12 – 24	0.5625	0.570	0.555
	211	24 – 36	0.5625	0.570	0.560
	199	36 – 48	0.5625	0.572	0.560
	187	48 – 60	0.5625	0.572	0.558
	175	60 – 72	0.5625	0.570	0.553
	163	72 – 84	0.5625	0.568	0.551
	151	84 – 88.6	0.5625	0.565	0.548

(1) Scan start was 1 inch below the centerline of the third horizontal weld, and 17 inches north of the centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-13. Primary Tank Vertical Wall Scan 2 - Plate #4 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / 2nd / Plate 4" (Page Att. 2-19)	143	0 – 12 (1)	0.750	0.769	0.754
	131	12 – 24	0.750	0.768	0.765
	119	24 – 36	0.750	0.768	0.766
	107	36 – 48	0.750	0.769	0.766
	95	48 – 60	0.750	0.769	0.766
	83	60 – 72	0.750	0.769	0.765
	71	72 – 84	0.750	0.773	0.758
	59	84 – 96	0.750	0.771	0.765
	47	96 – 104.1	0.750	0.764	0.747

(1) Scan start was 1 inch below the centerline of the fourth horizontal weld, and 17 inches north of the centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-14. Primary Tank Vertical Wall Scan 2 - Plate #5 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Wall Scan (inches)	Vertical Location of Wall Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Wall / 2nd / Plate 5" (Page Att. 2-21)	35	0 – 12 (1)	0.875	0.875	0.867
	23	12 – 19.5	0.875	0.873	0.867

(1) Scan start was 1 inch below the centerline of the fifth horizontal weld, and 17 inches north of the centerline of 24 inch Riser 030; Scan width was 15 inches.

Table 10-15. Primary Tank Vertical Wall Weld Scan - Plate #2 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Weld Scan (inches)	Vertical Location of Weld Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Weld / Plate 2" (Page Att. 2-23)	327	0 – 12 (1)	0.500	0.510	0.491
	315	12 – 15.3	0.500	0.510	0.499
Scan "Vert. Weld / Plate 2A" (Page Att. 2-25)	314.1	0 – 12 (2)	0.500	0.510	0.500
	302.1	12 – 24	0.500	0.510	0.493
	290.1	24 – 36	0.500	0.510	0.500
	278.1	36 – 48	0.500	0.510	0.495
	266.1	48 – 60	0.500	0.510	0.488
	254.1	60 – 72	0.500	0.510	0.481
	242.1	72 – 76.1	0.500	0.510	0.501

(1) Scan start was 1 inch below the centerline of the second horizontal weld; Scan width was 11.4 inches.

(2) Start of scan @ 12.9 inches of scan Vert. Weld / Plate 2; Scan width was 11.4 inches.

Table 10-16. Primary Tank Vertical Wall Weld Scan - Plate #3 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Weld Scan (inches)	Vertical Location of Weld Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Weld / Plate 3" (Page Att. 2-27)	235	0 – 12 [(1)]	0.5625	0.550	0.537
	223	12 – 24	0.5625	0.550	0.532
	211	24 – 36	0.5625	0.550	0.538
	199	36 – 43.5	0.5625	0.550	0.543
Scan "Vert. Weld / Plate 3A" (Page Att. 2-29)	191.5	0 – 12 [(2)]	0.5625	0.550	0.539
	179.5	12 – 24	0.5625	0.550	0.538
	167.5	24 – 36	0.5625	0.550	0.538
	155.5	36 – 43.8	0.5625	0.550	0.538

[(1)] Scan start was 1 inch below the centerline of the third horizontal weld; Scan width was 11.5 inches.

[(2)] Start of scan @ end of scan Vert. Weld / Plate 3; Scan width was 11.5 inches.

Table 10-17. Primary Tank Vertical Wall Weld Scan - Plate #4 (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Start of Weld Scan (inches)	Vertical Location of Weld Scan (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Vert. Weld / Plate 4" (Page Att. 2-31)	143	0 – 12 [(1)]	0.750	0.755	0.723
	131	12 – 24	0.750	0.755	0.739
	119	24 – 36	0.750	0.755	0.740
	107	36 – 48	0.750	0.760	0.740
	95	48 – 60	0.750	0.760	0.744
	83	60 – 72	0.750	0.760	0.737
	71	72 – 81.1	0.750	0.760	0.741
Scan "Vert. Weld / Plate 4A" (Page Att. 2-33)	61.9	0 – 8 [(2)]	0.750	0.760	0.744
Scan "Vert. Weld / Plate 4B" (Page Att. 2-35)	53.9	0 – 11.8 [(3)]	0.750	0.755	0.735

[(1)] Scan start was 1 inch below the centerline of the fourth horizontal weld; Scan width was 11.4 inches.

[(2)] Start of scan @ end of scan Vert. Weld / Plate 4; Scan width was 11.4 inches.

[(3)] Start of scan @ end of scan Vert. Weld / Plate 4A; Scan width was 11.4 inches.

Table 10-18. Primary Tank Vertical Wall Weld Scan - Plate #5 (via Riser 030)

Scan I.D. Number (Data Sheets)	**Elevation of Start of Weld Scan (inches)**	**Vertical Location of Weld Scan (inches)**	**Design Nominal (inches)**	**Measured Average (inches)**	**Measured Minimum (inches)**
Scan "Vert. Weld / Plate 5" (Page Att. 2-37)	35	0 – 12 (1)	0.875	0.865	0.849
	23	12 – 20.3	0.875	0.865	0.848

(1) Scan start was 1 inch below the centerline of the fifth horizontal weld; Scan width was 11.0 inches.

Table 10-19. Primary Tank Horizontal Weld - Plate #5 to Knuckle Scan, Plate #5 Side (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Horizontal Weld Scan (inches)	Horizontal Location of Weld Scan, Plate #5 Side (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Horz. Weld / Plate / Knuckle" (Page Att. 2-44)	From ~1 in. to ~4.85 in. above Plate #5 / Knuckle Weld	0 – 12 (1)	0.875	0.865	0.852
		12 – 24	0.875	0.865	0.852
		24 – 36	0.875	0.865	0.853
		36 – 48	0.875	0.865	0.852
		48 – 60	0.875	0.865	0.857
		60 – 72	0.875	0.865	0.860
		72 – 84	0.875	0.865	0.861
		84 – 96	0.875	0.865	0.861
		96 – 108	0.875	0.865	0.850
		108 – 120	0.875	0.865	0.861
Scan "Horz. Weld / Plate / KnuckleA" (Page Att. 2-45)	From ~1 in. to ~4.85 in. above Plate #5 / Knuckle Weld	0 – 12 (2)	0.875	0.865	0.861
		12 – 24	0.875	0.865	0.842
		24 – 36	0.875	0.865	0.852
		36 – 48	0.875	0.865	0.861
		48 – 60.5	0.875	0.865	0.852
Scan "Horz. Weld / Plate / KnuckleB" (Page Att. 2-46)	From ~1 in. to ~4.85 in. above Plate #5 / Knuckle Weld	0 – 12 (3)	0.875	0.865	0.851
		12 – 24	0.875	0.865	0.852
		24 – 36	0.875	0.865	0.846
		36 – 48	0.875	0.865	0.856
		48 – 60	0.875	0.860	0.825
		60 – 72	0.875	0.855	0.832

(1) Start of scan @ knuckle side vertical weld, north of south air line south of 24 inch riser; Scan width was 9.7 inches.

(2) Start of scan @ end of scan Horz. Weld / Plate / Knuckle; Scan width was 9.7 inches.

(3) Start of scan @ end of scan Horz. Weld / Plate / KnuckleA; Scan width was 9.7 inches.

Table 10-20. Primary Tank Horizontal Weld - Plate #5 to Knuckle Scan, Knuckle Side (via Riser 030)

Scan I.D. Number (Data Sheets)	Elevation of Horizontal Weld Scan (inches)	Horizontal Location of Weld Scan, Knuckle Side (inches)	Design Nominal (inches)	Measured Average (inches)	Measured Minimum (inches)
Scan "Horz. Weld / Plate / Knuckle" (Page Att. 2-47)	From ~1 in. to ~4.85 in. below Plate #5 / Knuckle Weld	0 – 12 (1)	0.9375	0.945	0.939
		12 – 24	0.9375	0.945	0.933
		24 – 36	0.9375	0.945	0.920
		36 – 48	0.9375	0.945	0.936
		48 – 60	0.9375	0.945	0.926
		60 – 72	0.9375	0.945	0.921
		72 – 84	0.9375	0.940	0.935
		84 – 96	0.9375	0.940	0.929
		96 – 108	0.9375	0.940	0.919
		108 – 120	0.9375	0.940	0.926
Scan "Horz. Weld / Plate / KnuckleA" (Page Att. 2-48)	From ~1 in. to ~4.85 in. below Plate #5 / Knuckle Weld	0 – 12 (2)	0.9375	0.940	0.933
		12 – 24	0.9375	0.940	0.911
		24 – 36	0.9375	0.940	0.923
		36 – 48	0.9375	0.940	0.930
		48 – 60.5	0.9375	0.940	0.912
Scan "Horz. Weld / Plate / KnuckleB" (Page Att. 2-49)	From ~1 in. to ~4.85 in. below Plate #5 / Knuckle Weld	0 – 12 (3)	0.9375	0.935	0.922
		12 – 24	0.9375	0.930	0.924
		24 – 36	0.9375	0.930	0.908
		36 – 48	0.9375	0.925	0.904
		48 – 60	0.9375	0.925	0.910
		60 – 72	0.9375	0.935	0.924

(1) Start of scan @ knuckle side vertical weld, north of south air line south of 24 inch riser; Scan width was 9.7 inches.
(2) Start of scan @ end of scan Horz. Weld / Plate / Knuckle; Scan width was 9.7 inches.
(3) Start of scan @ end of scan Horz. Weld / Plate / KnuckleA; Scan width was 9.7 inches.

11.0 EVALUATION OF INSPECTION RESULTS

The results from the inspection of tank 241-AP-106 are evaluated and compared with results of all other tank ultrasonic inspections.

11.1 TANK 241-AP-106 UT DATA EVALUATION

The UT P-scan data were interpreted by W. H. Nelson, COGEMA Engineering's Level III certified inspector. The P-scan data were also examined by J. B. Elder, an independent Level III certified NDE Inspector. Mr. Elder independently evaluated the P-scan raw data and concurred with COGEMA Engineering's interpretation (Attachment 2). The P-scan data have also been evaluated by PNNL as a third party review. Their results and conclusions were found to be consistent with those described in this report. Their P-scan data review is *Ultrasonic Examination Of Double-Shell Tank 241-AP-106 - Examination Completed November 2004*, PNNL report number PNNL-14971, Rev. 0 (Attachment 3).

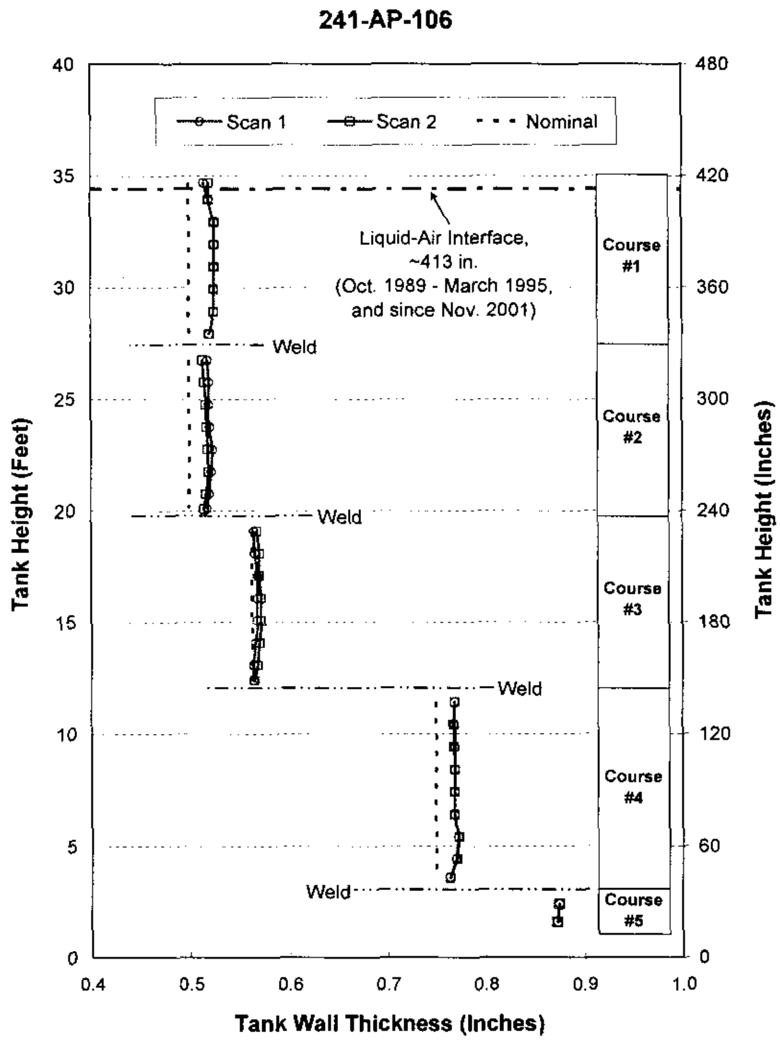
The results of the tank 241-AP-106 UT inspections indicated no reportable wall thinning, no pit-like indications, and no cracking in any of the areas examined. Figure 11-1 illustrates all of the "as-found" average wall thickness measurements of the primary tank vertical wall scans generated from the P-scan Inspection Data Sheets (Attachment 2). Each measurement plotted on Figure 11-1 is the average of all data collected over a 12 inch long by 15 inch wide scan area. Areas of interest for tank 241-AP-106 are the vapor space above the current liquid waste, the current liquid-vapor interface (approximately 34.4 feet or 413 inches), and the liquid region.

The overall average wall thickness measurements for the walls and weld HAZs are tabulated in Table 11-1. The UT data show that the primary tank average wall thickness values generally exceed the nominal values specified in the design documents. The UT data, when compared to construction specifications, drawings, standards, and codes (*241-AP Double-Shell Tanks Integrity Assessment Report*, Jensen 1999), reveal that the as-found condition of the tank plates and welds are all within the allowable design limits. A summary of the results associated with the areas examined is presented below.

Primary Tank Wall: Two vertical strips encompassing Plate #1 through Plate #5 were examined. The overall average wall thickness for each plate vertical scan varied only 0.005 inches from plate to plate (for same nominal-thickness plates) and a maximum of only 0.004 inches within the same plate (for all plates). All overall plate wall averages were between 0.001 inches less than to 0.023 inches greater than their nominal plate thickness values. No reportable wall thinning, pitting indications or crack-like indications were found.

Primary Tank Welds: One vertical weld in each of the four Plates #2 through #5 was examined. The plate walls adjacent to the welds averaged 0.013 inches less than (Plate #3) to 0.010 inches greater than (Plate #2) their nominal plate thickness values. No crack-like indications were found. There were also no reportable wall thinning or pitting indications found.

Figure 11-1. Scan Data Average Wall Thickness Compared to Nominal Plate Thickness



Primary Tank Knuckle-to-Shell Weld: A 21.0 feet region of the horizontal knuckle-to-shell weld was examined. No crack-like indications were found. There were also no reportable wall thinning or pitting indications found. The plate walls adjacent to the weld averaged 0.011 inches less than (Plate #5 side) to 0.001 inches greater than (Knuckle side) their nominal plate thickness values.

Table 11-1. Average Tank Wall Thickness Values

Scan Description	Scan Location	Scan 1 Average (inches)	Scan 2 Average (inches)	Average Thickness (inches)	Nominal Thickness (inches)	Average minus Nominal (inches)
Vertical Wall Scans [(1)]	Plate #1	0.5225	0.5231	0.5228	0.500	+ 0.023
	Plate #2	0.5201	0.5164	0.5183	0.500	+ 0.018
	Plate #3	0.5659	0.5693	0.5676	0.5625	+ 0.005
	Plate #4	0.7689	0.7689	0.7689	0.750	+ 0.019
	Plate #5	0.8740	0.8740	0.8740	0.875	– 0.001
Vertical Welds	Plate #2	0.5100	n/a [(2)]	0.5100	0.500	+ 0.010
	Plate #3	0.5500	n/a	0.5500	0.5625	– 0.013
	Plate #4	0.7578	n/a	0.7578	0.750	+ 0.008
	Plate #5	0.8650	n/a	0.8650	0.875	– 0.010
Lower Primary Knuckle Weld	Plate #5 Side	0.8643	n/a	0.8643	0.875	– 0.011
	Knuckle Side	0.9386	n/a	0.9386	0.9375	+ 0.001

(1) Scan 1 and Scan 2 were on the same plate.

(2) n/a – not applicable (only one scan performed)

11.2 DST ULTRASONIC INSPECTION DATA RESULTS COMPARISON

The following Tables 11-2 and 11-3 provide a summary of primary tank vertical wall inspection results and a comparison of primary tank wall thinning.

Table 11-2 reports the inspection results chronologically according to fiscal year (October 1 through September 30).

Table 11-2. Double-Shell Tanks Chronological Inspection Results Findings

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
AW-103	1997	None	None	None	None
AN-107	1998	None	None	None	None
AN-106	1999	None	None	None	None
AN-105	1999	None	None	Two very minute areas of a plate (20% maximum reduction in thickness) [a]	None
AZ-101	1999	None	None	One area of a plate (11.4% maximum reduction in thickness)	None
AY-102	1999	None	None	None	None
AP-107	2000	None	None	None	None
AP-108	2000	None	None	Two minute areas of a plate (13.8% maximum reduction in thickness).	None [b]
AW-101	2001	None	None	A pit like indication in a very minute area of a plate (16% maximum reduction in thickness).	None
AW-105	2001	None	None	None	None
AY-101	2001	None	Pit-like indication at historical liquid-air interface	Some pit-like indications identified as thinning	Three areas of 10% wall thinning in vertical welds
AN-102	2001	None	None	One minute area of a plate (11% maximum reduction in thickness)	None
AN-101	2002	None	None	One small area of a plate (12 % maximum reduction in thickness)	Four local areas near vertical welds (14% maximum reduction in thickness)

(Cont. on next page)

Table 11-2. (Cont.) Double-Shell Tanks Chronological Inspection Results Findings

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
AW-106	2002	None	None	One small area	10.4% maximum reduction in thickness
AY-101	2002	Not Investigated	None	72 areas of >10% wall thinning, most in the historical liquid-air interface in Plate #2 (20.2% maximum reduction in thickness)	Not Investigated
AW-104	2002	None	None	None	None
AW-102	2002 & 2003 (c)	None	None	None	None
AN-105	2002	None	None	None	Not Investigated
AP-101	2003	None	None	None	None
AP-105	2003	None	None	None	None
AP-103	2003	None	None	None	None (d)
AZ-102	2003	None	None	Six small areas in the vicinity of the liquid-air interface in Plate #2 (13.2% to 17.8% maximum reduction in thickness)	Three small areas of wall thinning near the Plate #1 vertical weld (10.9% to 16.8% maximum reduction in thickness)
SY-103	2004	None	None	Six small areas in the Plate #1 Vapor Space (10.4% to 12.8% maximum reduction in thickness)	None
SY-101	2004	None	None	Numerous areas in the vicinity of the historical liquid-air interface on Plate #1 (10.4% to 18.4% maximum reduction in thickness)	Numerous areas in Plate #1 and two areas in Plate #2 (10.6% to 17.3% maximum reduction in thickness)
SY-102	2004	None	None	Numerous areas in Plate #1 (10.1% to 12.5% maximum reduction in thickness)	One small area in Plate #1 (10.7% maximum reduction in thickness)

(Cont. on next page)

Table 11-2. (Cont.) Double-Shell Tanks Chronological Inspection Results Findings

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
AP-104	2004	None	None	None	None
AP-106	2005	None	None	None	None

[a] Based on a review of the tank 241-AN-105 data gathering technique in FY 1999, prompted by the FY 2002 results, the FY 1999 wall thinning data is considered questionable.

[b] Although below reporting criteria at the time, one linear crack-like indication 6 inch long by 0.142 inch deep in a nominal 0.750 inch thick plate was observed. Subsequent examination of tank 241-AP-108 in FY 2002 revealed no change in size.

[c] Primary knuckle examination using T-SAFT conducted in FY 2003.

[d] One linear crack-like indication 2.92 inches long in the weld heat-affected zone of a nominal 0.875 inch thick plate was detected. A follow-up inspection determined that the indication is a small area of incomplete fusion that is not open to either surface of the tank.

The inspection results in Table 11-2 show that the overall condition of the inspected tanks is satisfactory. Defects or minute reportable localized plate thinning may be due to various reasons, such as fabrication defects, construction damage or in-service corrosion.

Wall thickness data gathered from ultrasonic examination of twenty-five DSTs were compared to evaluate the degree of wall thinning that may have occurred among the tanks examined. These wall thickness data do not allow a direct calculation of wall thinning, since no measurements were made of original plate thicknesses at the time of construction. However, wall thickness data from ultrasonic testing may be compared to the specified nominal plate thickness. This assessment used the minimum wall thickness in each scanning area (generally 12 inches by 15 inches) from the vertical wall scans and then calculated the average for each plate using the minimum thickness values.

Table 11-3 provides a summary of wall thinning, defined as nominal plate thickness minus average minimum plate thickness[3], by nominal plate size, and by DST examined. The negative values in the table indicate where the average of all minimum values of plate thickness exceeds nominal plate thickness. The Table also provides the calculated average wall thinning and associated standard deviation by DST examined for all nominal plate thicknesses, and by nominal plate thickness for all DSTs examined.

Tank 241-AP-106 did not exhibit any significant thinning. Small degrees of average wall thinning were observed in the 0.5625 inch thick Plate #3 (0.006 inches) and in the 0.875 inch thick Plate #5 (0.012 inches).

[3] Average minimum plate thickness is defined as the average of all the minimum measured thicknesses for each scanning area (generally 12 inches by 15 inches) for a given plate size and DST.

Table 11-3. Tank Wall Thinning By Nominal Plate Size

DST	FY Examined	Wall Thinning* By Nominal Plate Size (Inches)						
		0.375"	0.500"	0.5625"	0.750"	0.875"	AVG	STD DEV
AN-101	2002	n/a	0.008	n/a	0.027	0.015	0.013	0.014
AN-102	2001	n/a	0.004	n/a	0.003	0.005	0.004	0.016
AN-105	1999	n/a	0.026	n/a	0.007	0.001	0.019	0.032
AN-105	2002	n/a	0.015	n/a	n/exam.	n/exam.	0.015	0.021
AN-106	1999	n/a	0.006	n/a	0.015	0.012	0.009	0.009
AN-107	1998	n/a	-0.018	n/a	-0.015	0.013	-0.016	0.017
AP-101	2003	n/a	-0.008	-0.003	-0.002	0.010	-0.004	0.008
AP-103	2003	n/a	0.008	-0.004	-0.009	0.007	0.000	0.012
AP-104	2004	n/a	-0.006	-0.016	-0.016	0.011	-0.010	0.014
AP-105	2003	n/a	0.004	-0.006	-0.002	0.010	0.000	0.009
AP-106	2005	n/a	-0.007	0.006	-0.012	0.012	-0.004	0.012
AP-107	2000	n/a	-0.011	-0.012	-0.017	-0.013	-0.013	0.008
AP-108	2000	n/a	-0.017	-0.012	-0.011	-0.005	-0.014	0.016
AW-101	2001	n/a	0.008	n/a	0.014	0.020	0.010	0.013
AW-102	2002	n/a	-0.019	n/a	-0.006	0.008	-0.014	0.012
AW-103	1997	n/a	-0.010	n/a	-0.005	0.004	-0.007	0.008
AW-104	2002	n/a	-0.036	n/a	-0.031	-0.007	-0.033	0.011
AW-105	2001	n/a	0.000	n/a	0.008	-0.003	0.002	0.018
AW-106	2002	n/a	-0.004	n/a	0.015	0.000	0.001	0.016
AY-101	2001	-0.011	0.030	n/a	0.018	0.012	0.030	0.029
AY-102	1999	-0.021	0.001	n/a	0.008	n/a	0.000	0.012
AZ-101	1999	0.021	0.027	n/a	0.020	0.003	0.024	0.011
AZ-102	2003	0.017	0.007	n/a	-0.011	-0.004	0.002	0.019
SY-101	2004	0.056	0.009	n/a	0.026	-0.030	0.015	0.020
SY-102	2004	0.042	0.007	n/a	0.009	0.031	0.012	0.014
SY-103	2004	0.041	0.008	n/a	0.019	-0.022	0.012	0.015
AVG:		0.021	0.001	-0.007	0.003	0.004		
STD DEV:		0.028	0.022	0.010	0.019	0.015		

* Thinning = nominal plate size – minimum thickness
n/a – not applicable; n/exam. – not examined

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12.0 FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The findings, conclusions, and recommendations from the UT inspection of DST 241-AP-106 are listed below.

- The primary wall vertical scans yielded overall average wall thickness values that generally exceeded the nominal values. The average wall thickness values ranged from 0.001 inches less than (Plate #5) to 0.023 inches greater than (Plate #1) their nominal plate thickness values.

- No reportable wall thinning was detected in any of the areas examined. Small degrees of average wall thinning were observed in the 0.5625 inch thick Plate #3 (0.006 inches) and in the 0.875 inch thick Plate #5 (0.012 inches). Of the 12 inch long vertical wall plate scans yielding minimums falling below the nominal values, the greatest deviation was 9.0% below the nominal (Plate #1, Scan 1), where reportable wall thinning is defined as greater than 10% below the nominal.

- No reportable pitting indications nor any crack-like indications were detected in any of the vertical wall plates.

- No crack-like indications were detected in any of the weld heat-affected zones.

- No reportable wall thinning or reportable pitting indications were detected in any of the weld heat-affected zones. The primary tank vertical weld scans (Plates #2 through #5) and the knuckle-to-shell horizontal weld scan (Plate #5 to lower knuckle) yielded overall average wall thickness values that ranged from 0.013 inches less than (Plate #3) to 0.010 inches greater than (Plate #2) the nominal values.

- According to a recent Tank Integrity Assessment Project DST Lifecycle Schedule, tank 241-AP-106 is scheduled for its second, standard UT examination in about nine years. Based on the results of this UT examination, it is recommended that this schedule be maintained – there is no reason to perform any near-term follow-up inspections on this tank. Following the second UT examination, inspection parameters such as wall thinning rates can be calculated and used to better quantify and evaluate any continual wall thinning or degradation.

  A visual examination of tank 241-AP-106 is scheduled in FY 2009 that will include visually examining the internal primary tank wall.

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